The American Biology Teacher

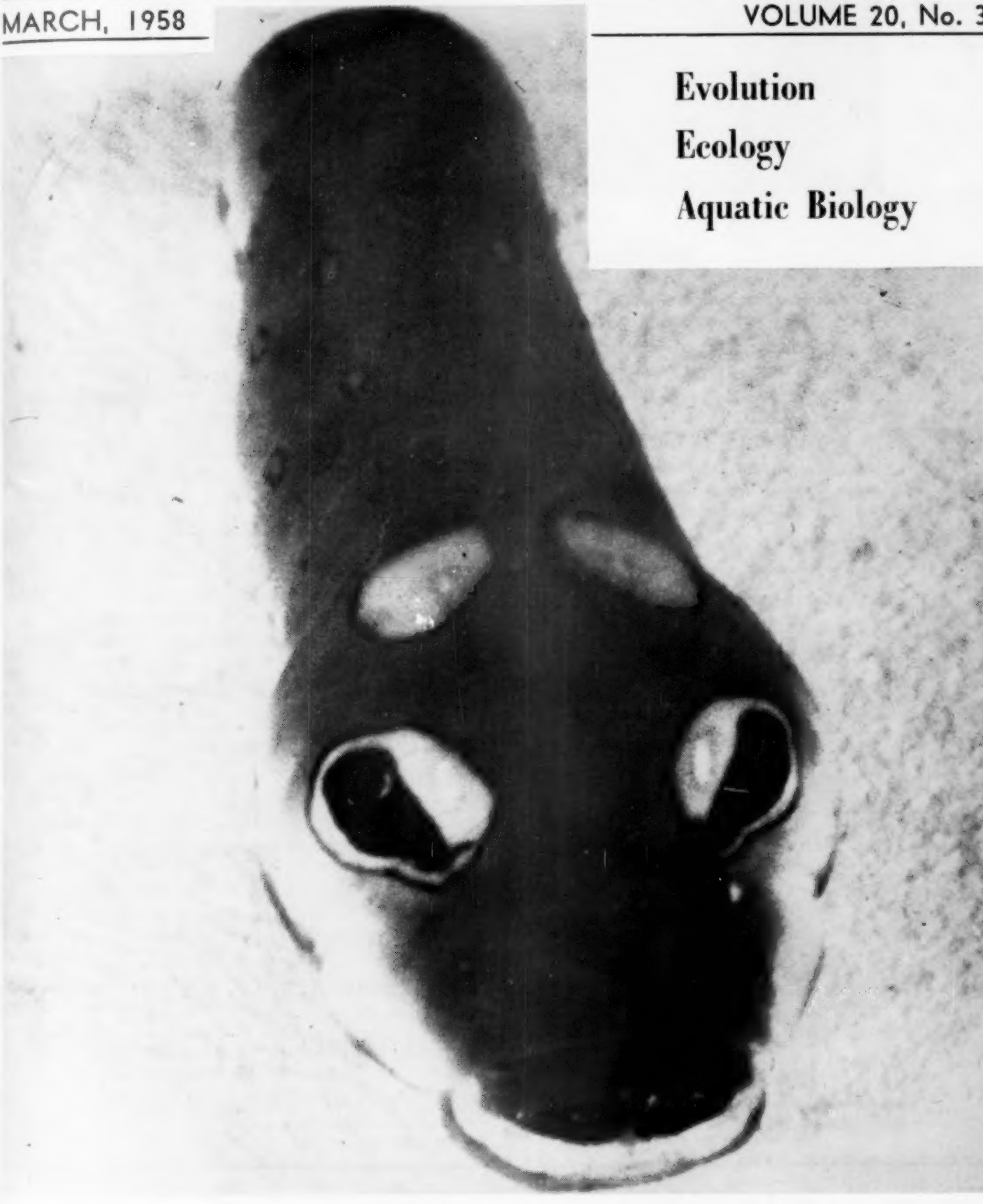
MARCH, 1958

VOLUME 20, No. 3

Evolution

Ecology

Aquatic Biology



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Cover Photograph

This is a head-on look at a caterpillar belonging to the Papilionidae. Photograph by Dr. Joseph M. Riedhart, Coto Research Station, Costa Rica. The black and white print was made from a 35 mm. color slide by projecting the transparency on Panatomic X cut film. Exposure, using a Kodak enlarger, was about 2 seconds at f/16.

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May. Entered as second class matter October 20, 1954, at the post office at Danville, Ill., under the Act of March 3, 1879.

Publication Office—Interstate Press, 19 N. Jackson St., Danville, Ill.

Co-Editors—RICHARD ARMACOST, Department of Biological Sciences, Purdue University, West Lafayette, Ind.; PAUL KLINGE, Coordinator for School Science, Indiana University, Bloomington, Indiana.

The Purdue University address will be the official editorial office. Manuscripts and all publication material may be sent to either of the Co-Editors.

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Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, PAUL WEBSTER, Bryan City Schools, Bryan, Ohio. Correspondence concerning advertising should be sent to the Managing Editor.

Annual membership, including subscription, $3.75, subscription to Journal, $3.75, individual copies, $.50, outside United States, $4.50, individual copies, $.50.

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At the business meeting of the National Association of Biology Teachers, held in Indianapolis, Indiana, December 26, 1957, the Board of Directors established a student membership, available to college students who intend to become biology teachers. Dues for these special student memberships were set at $2.00 per year. Application for membership may be made to the Secretary-Treasurer, Paul V. Webster, Bryan City Schools, Bryan, Ohio. Use regular membership blanks and mark student on it.

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Teaching the Major Concepts: Evolution[1]

EDWARD O. DODSON
University of Ottawa, Ottawa, Canada

Edward O. Dodson

Those of you who heard Professor Dobzhansky yesterday need not be convinced that evolution is one of the ideas which molds our lives, and I am honored to be accorded the opportunity to help bring an understanding of it to our high school and college students.

I would like to speak of four aspects of the study of evolution which seem to me to be particularly fruitful approaches for the teachers to hold the interest and illuminate the understanding of the students. First, historically, it was the concept of evolution which made possible some unity, some cohesive theory, in the enormously complex array of data and hypotheses which *is* biology. Second, the history of the world of life and its diversification from relatively simple beginnings *is* evolution, as studied in the paleontological record. Thus viewed, evolution is the Creative Act itself, than which there is nothing more fascinating. Third, because the data of evolution are drawn from all fields of biology, almost every lesson and experiment can be used to illuminate the subject of evolution in one way or another, or conversely, evolution supplies the rationale for every lesson. Finally, our knowledge of evolution is a fascinating mixture of well established facts and laws, reasonable secure hypotheses, tentative hypotheses, and tantalizing areas of ignorance. For this reason, it is a subject ideally suited for demonstrating to students the important facts that the books are not the final authorities, and that there are new frontiers of knowledge to challange them. Let us discuss each of these points briefly.

I have stated that the concept of evolution made possible some cohesive theory in biology. That biology participated in the great upsurge of the sciences in post-Renaissance times is well-known. The names of men such as Spallanzani, Redi, John Ray, Wolff, and Buffon are known to all of you. These men accumulated an enormous store of biological data, a store, however, which was rather chaotic, for there simply was no theoretical framework within which this vast array of data could be ordered. Linnaeus partially filled this gap with his systematic studies, in which he tried to classify the entire world of life, indeed, the entire phenomenal world.

The net result, however, was that he stimulated further biological exploration and fact finding without really satisfying the need for a fundamental theory, for the taxonomic system itself was not explicable. This may be illustrated by the problem of the construction of diagrams to represent the facts of taxonomy. Linnaeus at first tried diagramming these data as a map, with each species being assigned a certain area, and those species which resembled each other most being assigned adjacent areas. But however many times such a map might be redrawn, two defects seemed to be unavoidable: some similar species had to be separated, and some dissimilar species had to be placed side by side. It was finally concluded that a map simply was not a workable model of the organization of the living world. Many other models were tried, but all failed until the idea of a *tree of life* was tested. Diagrams based upon this concept worked, yet no one could understand why this should have been so, so long as the concept of evolution was not a part of the biologists' intellectual equipment.

Thus, by the time the *Origin of Species* was published, there was in the biological literature the accumulated data of 200 years of intensive biological exploration and experimentation, a burgeoning chaos. The concept of evolution provided the theoretical framework into which these previously disorganized facts could be arranged in meaningful order. Thus it became obvious that the data of taxonomy could be diagrammed as a tree,

[1]Presented to the Joint Symposium of the Teaching Societies at the AAAS meetings in Indianapolis December 28, 1957.

because, like the branches of a real tree, biological species (as well as other categories) result from growth and differentiation. And similarly, other categories of biological data could be fitted into the evolutionary framework. In the autobiography which he wrote for his children, Darwin answers those of his critics who said that he did not have a logical mind. He said that the *Origin of Species* was one long argument, and that it had convinced the majority of biologists, a thing which he believed not possible unless the argument were constructed with reasonable logic. Now the logic of the book is simply this: a wide variety of categories of biological data are examined, and it is shown that each is most easily understood on the basis of the proposition that living species have been formed by modification of pre-existing species, that is, by evolution.

Thus the role of evolutionary theory in biology has been comparable to the thermodynamic laws in physics: it is an underlying law which gives a basic theory, an understandability, to a great field of knowledge, one of the fundamental branches of science.

Second, an historical survey of evolution, as found in the record of the rocks, is the factual story of creation, and as such it holds a unique fascination. This story begins with the most primitive algae, found in the rocks of the Laurentian Mountains, in the shadow of which my home is built. It continues with the diversification of aquatic plants and the establishment of the major groups of invertebrate animals, both well exemplified by the Cambrian rocks which were first systematically explored by Darwin's friend, Sir Charles Lyell. Soon, some plants began to invade the lands, and animals were not far behind. Vertebrates appeared, at first the lowly ostracoderms, armored against a hostile world, but they soon gave rise to an array of fishes which filled the waters of the world. One of these, the lobe-fins of which a living representative had now been known for 18 years, developed adaptations which permitted it to exploit land habitats which had, thus far, been the exclusive realm of plants and invertebrates. Thus the amphibians arose, and their adaptive radiation led to types less dependent upon water, and with great potential for adaptive variation. These were the primitive reptiles, whose explosive diversification to form the varied array of dinosaurs during the Mesozoic Era has, at one time or another, fired the imagination of almost everyone. Certain of these modified reptiles gave rise to the birds and mammals, the dominant terrestrial animals for many millions of years. Finally, man appeared on the scene at least a half million years ago, and possibly much earlier.

This is a story of such great inherent fascination that it cannot be completely obscured even by so cursory a presentation as the foregoing. Of course, this story cannot be developed systematically at the high school level, for that presupposes extensive knowledge of both biology and geology. However, it is practical to introduce some information on the fossil forebearers of particular animals under study. Excellent illustrative material is readily available, for example, in some of the publications of the American Museum of Natural History, and the guide books of the British Museum are truly outstanding. Then too, the biological supply houses are generally able to provide a rather considerable array of fossils at moderate prices. But an especial opportunity is afforded by the collecting which the students themselves will do under favorable circumstances and with a modicum of encouragement. For example, my eleven year old son has, for the past three years been interested in collecting fossils. He rarely goes on a hike on a country road without finding some memento of the remote past. During most of that time, we lived in northern Indiana, and the gravel roads of the area have yielded him large numbers of crinoids, relatives of the starfishes which are abundantly represented throughout the mid-west. After three years of collecting, he now has well over two hundred specimens, representing a fair number of different animal types. Not a few of these have served as the basis of interesting and effective class sessions under the leadership of his gifted teacher, Mrs. Myrtle Burns, who was selected as Indiana's outstanding teacher in 1956. These fossils have a high instructive value because they tend to make the life of the past real to the students; and while the students are unlikely to collect a nicely graded series of fossils in any line of descent, still their experience with these fossils makes it far easier for them to visualize the idea of descent with modification.

The third teaching approach to evolution

which I would like to discuss is that, because the data of evolution are drawn from all fields of biology, almost every lesson and experiment can be used to illuminate the subject of evolution in one way or another, or conversely, evolution can supply the rationale for every lesson. A few examples may be given. In almost every course in biology, some representative vertebrate skeleton is studied. After the students have learned the names of the various bones of, let us say, the frog skeleton, they can be shown skeletons of several other classes, for example, a lizard, a bird, and a mammal, even man if a human skeleton is available. That they can then recognize and call by name a number of the homologous bones in all of these diverse animals is indeed a revelation to the students. It is difficult to miss the inference of relationship, or the explanatory value of the evolutionary concept.

Again, if any terrestrial vertebrate embryo, such as the chick or a mammal be studied, gill slits will be a prominent feature at an early age. Viewed simply as a developmental stage, this is an inexplicable thing. But the evolutionary concept at once provides a simple explanation of the fact and is bolstered by the observation.

Field work in biology is often conveniently provided by a study of the local birds. In most localities, certain families or genera may be represented by numerous species. In many instances, the similarities of such species may be so close that they are readily confused, and the ranges of variability for some characters of some species may overlap. The many species of warblers, which in a few months will pass through this region on the way to their subarctic breeding grounds, exemplify this phenomenon beautifully. Such complexes of closely similar species are quite evidently to be expected on the basis of descent from a fairly recent common ancestor. Again, the observation lends support to the concept of evolution, and the later in turn makes the observation intelligible.

Such examples could be multiplied indefinitely, and could be drawn from every field of biology. They all share these characteristics, that the data contribute to the understanding of evolution, and the concept of evolution makes the data understandable.

Finally, I would like to emphasize that our present knowledge of evolution is a fascinating mixture of well established facts and laws, reasonably secure hypotheses, quite tentative hypotheses, and tantalizing areas of ignorance. For this reason, it is a subject ideally suited for demonstrating to students two of the most important things which they should take away from their course in biology: first, nature, not the text, is the real authority; and second, there are new frontiers of knowledge in biology to challenge them.

As an example of a well established law in evolutionary science, I will speak of the effectiveness of natural selection in modifying the characteristics of species. This was originally proposed by Darwin on the basis of a very extensive array of inferential evidence. Because of the cogency of this evidence, he soon earned the agreement of the great majority of biologists. But all scientists like to test their inferences with experiments which will not admit of alternative explanations. For many years, all attempts at crucial experiments to test the effectiveness of selection failed. By the turn of the century, many biologists had become pessimistic about the very possibility of gaining any experimental knowledge of the mechanics of evolution. In recent years, however, many approaches to this problem have been successful. Laboratory populations of plants and animals have been modified by the action of selective conditions, and the actual occurrence of parallel phenomena in nature has been demonstrated beyond a reasonable doubt. Thus natural selection may be regarded as a well established fact.

As an example of a reasonably secure hypothesis, I would like to speak of Bergmann's rule, that within a given species or genus, the more northerly populations have a larger mean body size than do the more southerly populations. The theoretical basis for this proposition is simple and convincing: as a body grows in size, its surface area increases as a square while its volume increases as a cube, and hence the proportional heat loss at the surface of the body should be smaller for a large animal. The selective value is obvious. Further, actual data on natural populations has shown that in large numbers of species and genera the rule holds, and this in animals as diverse as boars and titmice. Recently, however, evidence has been produced

which indicates that physiological factors in the ability of an animal to maintain normal temperatures in the face of cold stress may be so much more important than size differences that the latter are swamped out. Thus, in spite of its appealing physical basis and the numerous measurements in its support, Bergmann's rule does not have quite the force of a natural law.

Again, some hypotheses in evolutionary science are quite tentative or even frankly doubtful. A good example of this is provided by Darwin's much discussed theory of sexual selection. It is a striking fact of nature that in many species one sex is highly ornamented while the other is relatively plain. The plumage differences of many species of birds are familiar to everyone. Darwin was unable to explain these by the general theory of natural selection, but he thought that they would be explanable if the ornamented sex courted the other, and the plain sex selected from among the suitors those with the most pleasing ornamentation. At first glance, this theory seems almost obviously true, and there are indeed many data which support it. But there are also many contradictory data and some indications that even the favorable data may be best interpreted in a very different way. For example, mating in the fruit fly is commonly preceded by an elaborate courtship dance by the male. In terms of the theory of sexual selection, the females should show a preference for those males which dance most beautifully. Unfortunately for the theory, however, it has been demonstrated that the effect of the dance upon the female is to arouse her sexual receptivity, but once aroused, she will mate with a nondancer as readily as with the male whose dancing has aroused her. Thus Darwin's old theory of sexual selection must be considered as a very insecure hypothesis.

Finally, there are many tantalizing areas of ignorance in evolutionary science. Let me mention a few of these. The title of Darwin's major work is '*The Origin of Species*', and the concept of taxonomic species has ever since played a very important role in evolutionary studies. Yet, not only is there no general agreement on what a species actually is, but there is not even general agreement on the question of whether the species is a real natural unit or simply a logical construct, useful for forensic purposes, but not corresponding to any reality in nature. For practical purposes, the dictum of Darwin is still valid, that a species in any particular group is whatever a competent specialist on the group considers a species to be. This is indeed a very fundamental problem.

Again, the paleontological record gives most impressive support to evolutionary science. Some specific lines of descent have been worked out in considerable detail, like the celebrated case of the horse. But more typically the fragmentary nature of the record of the rocks results in fragmentary information about specific lines of descent. Thus we know that the ancestry of man must be sought among the lower Primates. But the discussion of specific probable lines of descent is fraught with controversy at almost every level. Nor does this type of problem apply only at the species level: it may be equally true of higher groups. For example, Darwin described the origin of the flowering plants as an "abominable mystery," and the situation has not changed in the intervening century.

Still another example may be taken from the study of the mechanics of evolution. Most scientists are never quite satisfied until they have succeeded in analyzing their data mathematically. In recent years, a number of brilliant biologists have investigated the transformation of biological species from a statistical viewpoint, starting from the regularities of Mendelian genetics. These mathematical analyses are very impressive, but as yet very little progress has been made in transferring these from the calculating machine to actual species in nature. Even some of the most fundamental constants have not been tested against natural populations.

The study of evolution, then, is very much in a state of flux. It includes some firm guide posts, such as natural selection; but it also includes fascinating frontiers, the exploration of which is worthy of the very best students. I shall be very happy indeed if some of the suggestions which I have given prove helpful in turning the professional ambitions of some of your better students toward biology in general and toward evolution in particular. Beyond this, I feel confident that a biology course organized on an evolutionary basis and presented with evolutionary emphasis will be interesting to the majority of students.

Increasing the Biological Background of Secondary School Biology Teachers

JAMES A. PETERS
Brown University

The past few years have seen a series of articles in the *American Biology Teacher,* all pointing out the fact that a shortage of teachers trained to teach biology exists, that financial support for people wishing to teach biology but wanting to do graduate work is short, and that it is the responsibility of our colleges and universities to take an active part in the solution of these problems. Thus, Fuller (Vol. 18, 1956, p. 15) stated, "The student who is preparing to become a teacher of biology obviously should have as many basic courses in biological sciences as he can fit into his college program. The better trained a teacher is in subject matter, the more enthusiastic and the more stimulating he is likely to be in his teaching." Behnke (Vol. 17, 1955, p. 197) wrote, "The AAAS Cooperative Committee on the Teaching of Science and Mathematics has been acutely aware of the rapidly-increasing shortage of science and mathematics teachers and the inadequacy of the training of many of them." Behnke also said, "Students with an interest in high school teaching and with the necessary aptitudes in science and mathematics either have not been encouraged to prepare for teaching or have been discouraged from making such preparation." Gering (Vol. 17, 1955, p. 31) reported that "Only 59% of the high school biology teachers have a college major in the biological sciences." Finally, Breukelman, recording the discussion of Petry's paper (Vol. 17, 1955, p. 13) said, "Colleges must assume responsibility for inservice training of teachers of biology, in order to build up the breadth of training necessary for teaching such synthesizing topics as evolution." This constitutes a report of what Brown University is trying to do to alleviate some of these problems.

There is growing concern on the part of science faculties, research organizations industry, national scientific societies, and public health organizations with regard to the future supply of active participants in biological research. Although the problems to be solved are increasing geometrically, there is no corresponding increase in the personnel engaged in the solution of these problems. This is in spite of the fact that biology offers perhaps the most basically and intrinsically interesting areas of research in science today, as well as maximum opportunity for contribution to the welfare of mankind, for biological advance is seldom if ever measured in the amount of increase in destructive abilities of man or nation.

One of the primary sources for incipient biologists is the enthusiastically taught high school biology course, in which the scope and ramifications of biology as a science and an area of active, fermenting research are pointed out. Unfortunately, this type of biology course is seldom offered, primarily because our secondary school faculties are trained as teachers, not as biologists, or physicists, or other professional categories. They seldom regard themselves as active participants in the science they teach, and as a consequence it is impossible for them to communicate an enthusiasm which they themselves do not feel. This enthusiasm must come primarily from a thorough knowledge of the field, and some experience in the procedures pertinent to that field, including that of active participation in research.

The Master of Arts in Teaching program at Brown University is based squarely upon the concept that successful teaching is dependent upon thorough familiarity with the subject matter of the field to be taught. Every student taking part in the "MAT" program carries more course work in his subject field than in teacher training courses in the education department. In the biology course in the MAT program, the student engages in laboratory work that places emphasis upon individual development of techniques, the or-

ganization of a research plan, and the carrying out of a program of experimental analysis. We assume that the student will feel himself more a part of the field of biology if he has made a contribution, however modest, to the body of accumulated knowledge of that field. Our emphasis lies in the thorough understanding of the field of biology, with the hope that therein lies the method for avoiding rote work and copybook teaching in secondary schools, which is usually a direct consequence of a teacher trying to stay one jump ahead of his students.

We have three categories of students in our MAT program in biology. They are, first, the student coming directly from a liberal arts college or university, who has had a good undergraduate training in biology, and who wishes to go into secondary school teaching; second, the student coming directly from a teacher's college or normal school, who has a fairly thorough training in teacher training courses, but is often deficient in depth in biology; and third, the in-service teacher, who has had considerable classroom experience, but wishes to broaden his knowledge of biology as it is today. Each of these categories has its own problems with regard to post-graduate study, but the biggest education problem of the first seems to be money; of the second, opportunity; and of the third, time.

We are solving these problems at Brown University in a variety of ways. The first group, those with adequate training in undergraduate biology, will be offered teaching assistantships in the department of biology for the first time in the fall of 1958. Obviously, these assistantships can be made available only to people as well trained in the field as our graduate students in the biology department. We offer these teaching assistantships as an incentive toward additional training in subject matter depth and in teaching techniques prior to the acceptance of a teaching position. This will relieve the necessity of trying to complete graduate work through attending summer schools over a period of years.

The second group, those who will have been adequately trained in methodology courses, but who feel the need of stronger background in biology, probably will not be qualified for assistantships. For these we offer scholarships that will be the equivalent in stipend of a teaching assistantship, plus tuition. It is planned that these scholarships will be awarded for one year only, and that during this year the student will take departmental courses in biology and in other areas of deficiency, on a full-time basis. At the end of the first year, if their work has been on a satisfactory level, they would be offered a teaching assistantship within the department, during which time they could complete the requirements for the MAT degree.

The third group, the in-service teachers, have already indicated their interest in additional training, through their attendance and enthusiastic support of the many National Science Foundation Summer programs, evening courses, workshops, and so on. The primary problem for the few in-service teachers in our MAT program is one of time, for they find their teaching loads so great that they cannot concentrate full efforts on their studies. They should have the opportunity to obtain a leave of absence from their current position, presumably without salary, in order to spend a full year on campus, pursuing a full-time program.

For well-qualified individuals, selected for demonstrated success in secondary school biology teaching and for a proven academic record, we have set up a program of financial support, which will include a cost-of-living stipend, tuition, and additional support for dependents. This, we hope, will give time and leisure to engage in studies in depth in biology, without causing any great financial hardship.

Our primary problem now is making our program known to possible candidates in all three areas, so that they can apply in sufficient time. We would like to ask the cooperation of the readers of the *American Biology Teacher* in calling the attention of seniors in their institutions who have expressed an interest in secondary school teaching to this notice. We are also interested in receiving applications from in-service teachers who fit the third category, and would be able to *register in the fall of 1958. Correspondence should be directed to the Dean of the Graduate School, Brown University, Providence 12, Rhode Island.*

Providing for the Gifted Through Special Interest Activities[1]

DOROTHY VAUGHN
Neodesha High School, Neodesha, Kansas

In the Neodesha High School a program of work has been developed which is designed to provide additional opportunity for students gifted with scientific and mathematical aptitudes. Primarily, this was developed for the student with outstanding ability. However, and student with the interest, regardless of his ability, is encouraged to plan and participate in a science or mathematics project.

The program described in this report might not be effective in all situations. Each school must develop its own operational approach adapted to its own partciular situations. There is not a shortage of students who could become future scientists. There appears to be a shortage of opportunities to develop their abilities.

The community, school board, administration, and local faculty must all cooperate if such a program of special interest activities is to become effective. The purpose of the program is to discover and encourage those special students with scientific and mathematical talents, and to fulfill their needs.

This cannot be accomplished in the typical classroom containing varying degrees of mentalities and abilities. Some special plan must be put into operation to meet the needs of a smaller and more select group with special interests. They need guidance to accomplish certain goals. We strive to develop initiative, dependability, responsibility, leadership, and a working knowledge of scientific methods and attitudes. Those who participate must have an opportunity to plan a program and work it out by personal research rather than setting up a hobby-type collection of items or a mere display of equipment or charts.

Various means of obtaining these purposes are put into effect. No attempt is made to select the group to participate in research. The program is available to all who care to take part regardless of record, IQ, or reading scores. No boy or girl is forced in any way to enter upon this program. Also, there is full freedom of students to flow out of it as well as into it.

A few drop out of the work—the plan seeks its own level. Some find that athletics and social events are more important to them than science. Others find they are not fitted for the work. Still others lack originality.

From those who show promise of being research scientists, mathematicians and teachers of the future, regardless of the field they choose to enter, the experience the students receive from their program is valuable. A former member of our group is now enrolled in pre-law school.

No class period is set aside for this special interest work. Some are not enrolled in a science class. They find their own time for work in the field, before and after school, on week ends or during lunch hours. Provision is made for any student to have access to the laboratory and equipment during library periods and occasionally at night. A place is set aside for them to keep supplies, apparatus, animals or materials for research. Each one must assume responsibility for maintaining his needs and respect the property of others.

No student is expected to work without guidance or observation by a teacher or trained personnel. Neither is a teacher expected to be an expert in all fields. Nor does he have time to spend many hours aside from routine duties. A group of twenty active and ambitious research students can soon drain all the energy and time of even the most ambitious set of instructors.

The trained personnel of a community can play a big part in a program of this kind. For the most part they are willing and anxious to cooperate and find it stimulating to aid an alert student. This also serves as an aid to a good public relations program.

[1]Presented at the NABT meetings, American Association for The Advancement of Science Annual Meeting, Indianapolis, December, 1957.

Each community will offer a different set-up of aides. We have made use of the training and experience of the following local industries and citizens during the activities of the past year:

The Standard Oil Co. of Indiana has a well-equippd laboratory incorporated in their plant in Neodesha. Members of its staff hold advanced degrees from some of our nation's top schools. They have taken several of our interested students into their laboratory, trained them in the use of specialized equipment and guided them in petroleum research.

The local hospital has provided specialized and sterilized equipment and blood samples for certain studies. One student learned to type blood in the hospital laboratory.

A graduate bacteriologist, who is now a housewife, has given generously of her time and knowledge.

A local physician has aided a student who is interested in surgery. Not only did he advise, but he also gave many evenings of his valuable time. He took the student to the State University for materials and furnished some of the expensive equipment and supplies needed for a comparative brain study.

The photographer has taken many colored slides and even purchased a special attachment for his camera so he could take colored microphotographs. He not only gave of his time but furnished all materials.

A former geologist guided a junior high school student through a project dealing with copper.

Typists in the community have cut stencils for the papers that were written as a climax to the research. A former high school English teacher read proof for some of these papers. The local faculty also aided in this respect. The faculties of colleges and the State University have advised and aided whenever we sought their valuable help.

Three members of the high school faculty have sponsored the work during the past year. All departments gladly aided when their assistance was needed.

As can be expected, this program does not operate without conflicts and problems. There has to be a give and take policy among all departments. These students are active in all fields and sometimes find themselves involved in more than one activity scheduled for the same time. They must make a decision, and we do not advocate the choice always be in science or mathematics. We do not wish to develop a one-sided individual. We are anxious for each one to become well-rounded and experienced in many scholastic and extra-curricular activities.

Those who have continued in this program have each engaged in some "original" research work—some on college level. It is a gratifying sight to watch young people tackle problems and use their own abilities to solve that problem and emerge with a solution. They have learned laboratory techniques, the use and operation of many types of laboratory equipment, have gained skills in handling materials, have prepared exhibits of their work for demonstration before other students and at science fairs and have prepared a scientific paper suitable for publication. In their senior year they engage in the Annual Westinghouse Science Talent Search.

This program has been developing in our school for four years. Results are now showing up in the accomplishment of past participants who are now enrolled in college.

We feel we can say that our program has greatly benefited those who have participated. One boy is now enrolled as a sophomore in college. (He was our first and only member four years ago.) He has been given a scholarship each of his two years in college, has had part time employment in the botany department, and is majoring in chemistry.

Five members of last year's graduating class are now attending college on scholarships—one a Summerfield Scholarship in the State University. One of this group is employed by the State Geological Survey as clerk and one has a part time job in a museum. Two of these were honorable mentions in the National Merit Scholarship Competition. Two others were honorable mentions in the Westinghouse Talent Search last year. One was winner of the Kansas Science Talent Search and three were honorable mentions of the same Search. Five of their papers have been published in the *Kansas Transactions of Science*—a publication of the Kansas Academy of Science.

The record of the present year is also quite satisfying.

Last summer four of our students attended the First Annual Science and Math Camp at the University of Kansas. One of this number has dropped out of the program as he

is also a talented athlete. Two expect to become apprentices in the camp which will be held this summer. The other member has been enrolled in the Pre-Collegiate Science Program of The Worcester Foundation in Southborough, Massachusetts. This is a nine-week session of training which will be given twenty-four youth from the United States and Puerto Rico.

This year we had a winner in the Westinghouse Science Talent Search. The five day all-expense trip to Washington, D. C., was a wonderful experience and brought attractive offers of scholarships from several schools. She appeared on the Georgetown Radio and Television Forum with a panel of experts and young scientists discussing the work they were doing in cancer research. The National Cancer Institute of The National Institute of Health in Bethesda, Maryland, is interested in the research she did in an attempt to produce an antibody for Rous sarcoma virus. They have suggested further research for her and she hopes to continue the project in college. They state that the project is worthy of research toward an advanced degree. This same student passed the first barrier of the Elizabeth M. Watkins Scholarship test but was unable to compete in the finals. This called for one of those choices to be made. The test came at the same time as the Washington trip, and she decided to take the trip instead of the test. She also received an honorable mention in the National Merit Scholarship and first place in the Kansas Science Talent Search.

Another student was an honorable mention in the same Westinghouse Science Talent Search. She was also rated an honorable mention in the Kansas Science Talent Search.

Twenty-five members of the Kansas Junior Academy have been selected to present their papers before the Kansas Academy at its Annual Meeting at Kansas State College on May 3, 1957. These were selected as the highly superior presentations from the six district meetings which were held throughout the state on March 29, 1957. Of this total number of twenty-five, ten of them are from Neodesha.

Four members won fifty-dollar scholarships to Kansas State Teachers College of Pittsburg, Kansas, at the Science Fair held there in March.

Four received grants for research during the year from The American Association for the Advancement of Science and the Kansas Academy of Science.

Many of them have presented their papers and taken their exhibits to local clubs and professional organizations. It has been a valuable experience to appear before the public and express their findings.

If this seems a bit boastful it is our purpose to show that the needs of exceptional children can be met by our project method as carried on outside the classroom. Our method of operation does bring results.

We must keep in mind that no school is likely to maintain a consistent high level of success. It is bound to hit a lull at some time. When this does happen, plans must be strengthened to overcome the low point and strive to again achieve a high level of attainment. We must always keep in mind that the end result is the student and what he can do for himself and for society in general.

THANK YOU WARD'S

Ward's Natural Science Establishment has just published 15,000 copies of the new N.A.B.T. membership brochure at no expense to our organization.

N.A.B.T. members wish to thank Ward's and particularly Mr. William Gamble for this friendly gesture.

Interesting Article

WHEN A MAN-EATER ESCAPES, Carey Baldwin, Sat. Ev. Post, Jan. 25, 1958, pp. 28-29, 44.

Have you ever wondered what might happen if animals escaped from the zoo? Do they ever escape? This article contains many interesting incidents about zoo animals and we who come to look at them.

KEEP THEM ALIVE! E. Ross Allen and W. T. Neill, price $1.00.

How to keep snakes, lizards, turtles, alligators, caimans, and crocodiles in captivity. Cages, accessories, food, feeding habits, moisture, temperature, sunlight requirements, diseases and their prevention or cure, breeding in captivity, etc. Inside and cover illustrations, feeding chart, and bibliography; in attractive glossy cover. An important book for the amateur reptile collector, herpetologist, naturalist, zoo curator, biology teacher, etc.

Another Approach to Ecology

THOMAS G. OVERMIRE
Shortridge High School, Indianapolis, Indiana

The study of ecology is both a frustrating and a challenging topic for many high school biology teachers. The most satisfactory way to teach the unit is in the field, but limited class time and problems of travel drastically restrict field studies in most cases. In the classroom a lack of stimulating laboratory experiences is a definite handicap. In addition, most textbooks confine the discussion of ecology to: (1) a study of three or four distinct habitats, (2) a discussion of a balanced aquarium, and (3) the application of "all this" to conservation. Too frequently the student emerges with a mind filled with odd bits of information but with no real unifying concepts. To help the student develop an appreciation for a fuller meaning of the ecological concept, the method that follows was developed.[1] The idea is not original, but the application may be a new one for some teachers.

The method involves the use of distribution maps. Each student is given a basic set of mimeographed maps (maps 1-12) for his own use. Additional maps (such as maps 13-18) are made available from time to time. Questions involving correlations to be drawn from these maps are assigned as homework. From the outset it is necessary to insist that all correlations must come from the maps alone. Supplementary ideas from newspapers, textbooks, or friends cannot be allowed. If the student is to develop analyzing ability he must learn to develop his conclusions from authentic data (in this case, the maps). He must learn not to be led astray by ideas that he has "always known to be so"—ideas that may or may not be valid.

In preliminary discussions with the students it usually becomes apparent to them that they know very little about Indiana, other than that the state is flat, is a good place to grow corn, and is hot in the summer. Since it has been estimated that fully 45% of the native species of plants growing in the state are on edges of their ranges, it is obvious that Indiana is much more complex than most students realize.[2]

An endless number of questions can be taken from maps such as these. Some representative questions might include:

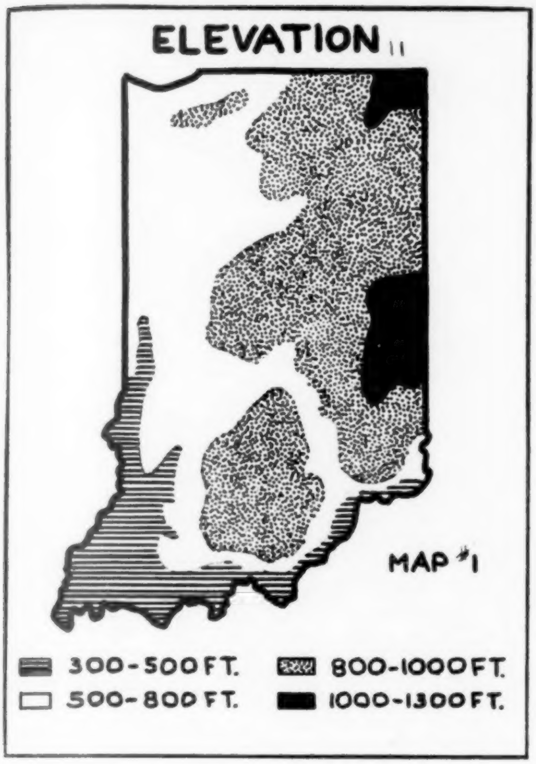
1. What effect does elevation have on the length of the growing season?
2. What factor seems to have had the greatest influence on the distribution of Sweet Gum?
3. What effect has glaciation had upon soil formation? upon topography?
4. What habitat does the Blue-Winged Teal use for nesting?
5. Does the Purple Cliffbreak Fern show a preference for soil type? for elevation? for temperature? for pH?
6. In what sort of habitat are pheasant found?
7. The coal and oil found in Indiana come from the southwestern portion of the state. What strata of bedrock furnishes these resources?
8. What has determined the location of the prairie? of beech-maple forests?
9. Does the amount of summer precipitation or the amount of winter precipitation have the greater effect upon erosion?
10. Game squirrels (fox and gray squirrels) are found throughout the state, but they are much more common in the southern half. Why?

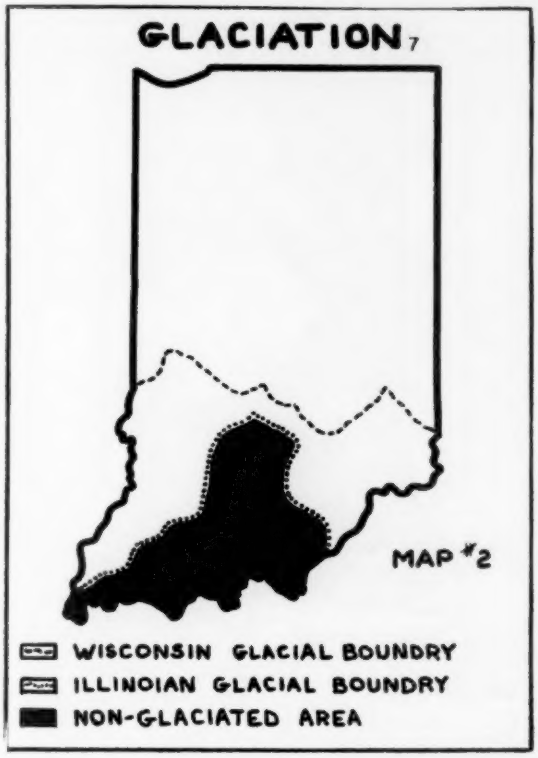
Many of the correlations are obvious ones. The student must be cautious, however, or else he may be lulled into believing that his judgment has become infallible. He must realize that the conclusions he arrives at may not show the full story. For instance, in the question concerning the concentration of game squirrels it is probable that farming practices and human population pressures are critical considerations. Yet neither of these factors is considered in this set of maps. It should gradually become evident to the student that at least some of the inter-relationships are subtle and complex. He should eventually realize that distributions are controlled by a variety of factors, and that it is necessary to account for all factors before analysis.

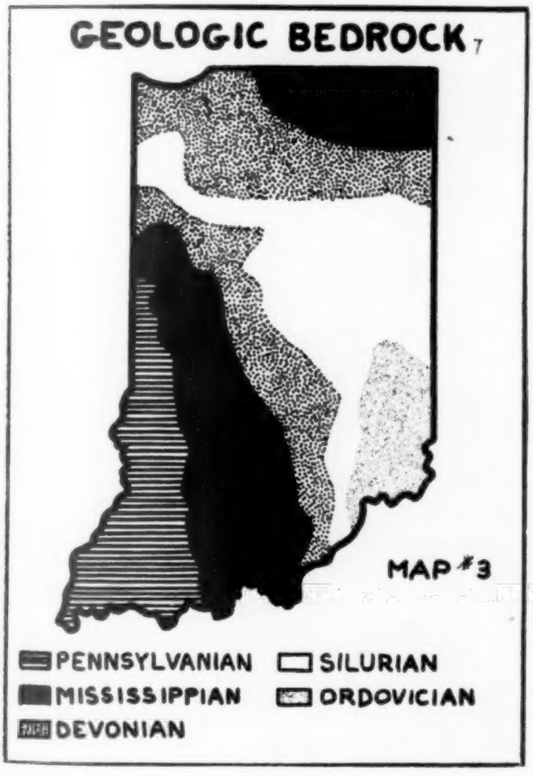
At the close of the unit additional maps and

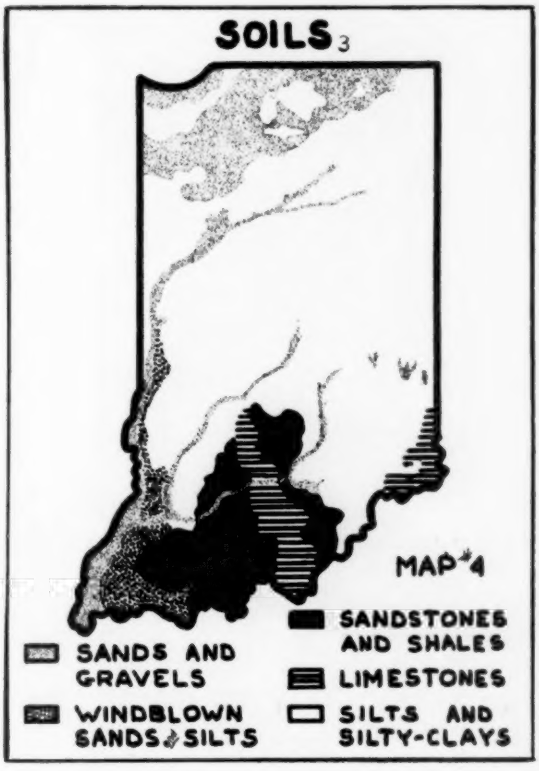
[1] The ecological concept is certainly not restricted to plant and animal relationships or to conservation. It is involved just as much, for instance, in the study of the "thermostat" control of body temperature or hormone balance as it is in a study of the web of life. If the student can once develop an awareness of this concept he will find infinite applications.

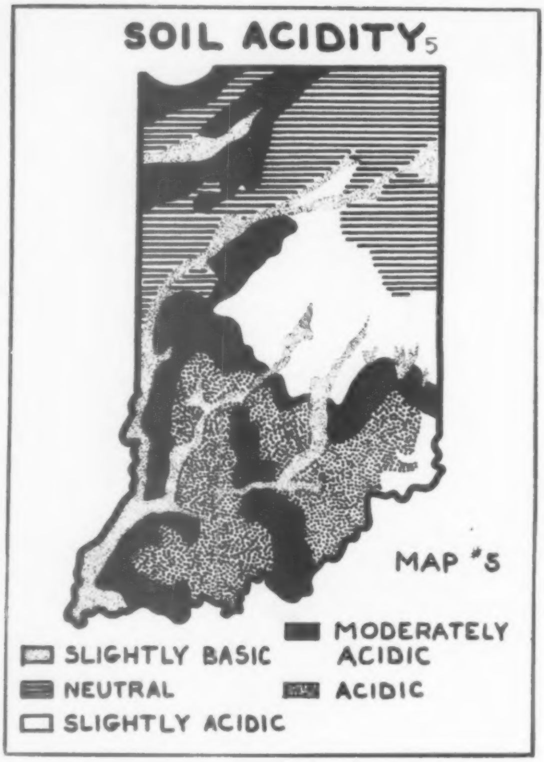
[2] Ray C. Friesner, "Indiana as a Critical Botanical Area," *Ind. Acad. Sc.*, 46-28-45. 1937.

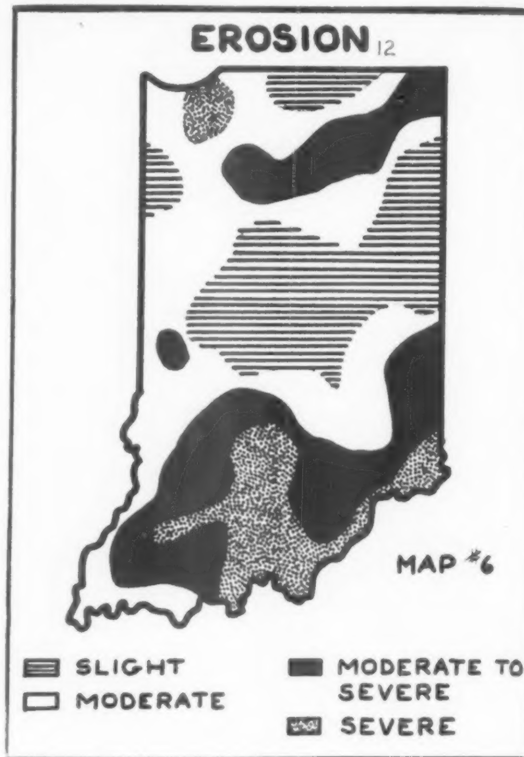

ELEVATION 11
MAP #1
300-500 FT.
800-1000 FT.
500-800 FT.
1000-1300 FT.

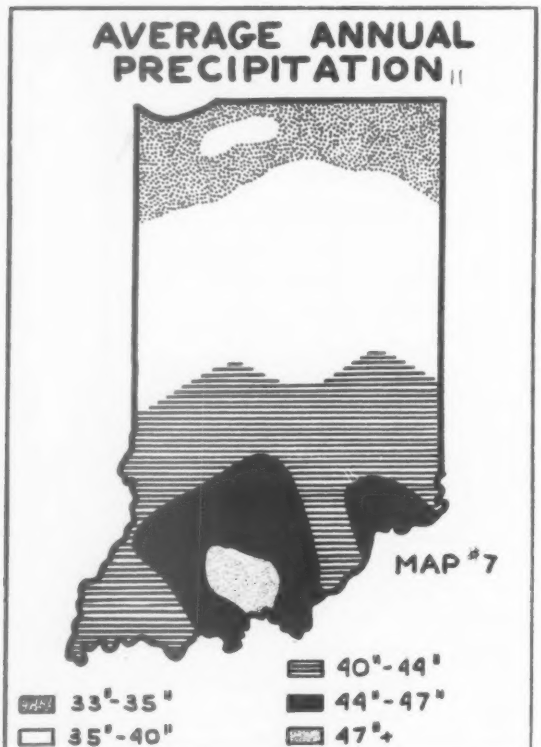

GLACIATION 7
MAP #2
WISCONSIN GLACIAL BOUNDRY
ILLINOIAN GLACIAL BOUNDRY
NON-GLACIATED AREA


GEOLOGIC BEDROCK 7
MAP #3
PENNSYLVANIAN
SILURIAN
MISSISSIPPIAN
ORDOVICIAN
DEVONIAN

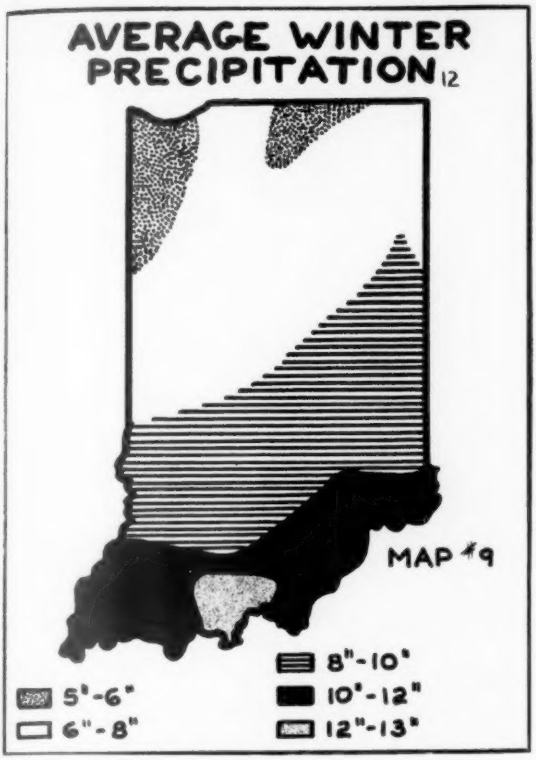

SOILS 3
MAP #4
SANDSTONES AND SHALES
SANDS AND GRAVELS
LIMESTONES
WINDBLOWN SANDS & SILTS
SILTS AND SILTY-CLAYS


SOIL ACIDITY5
MAP #5
SLIGHTLY BASIC
NEUTRAL
SLIGHTLY ACIDIC
MODERATELY ACIDIC
ACIDIC

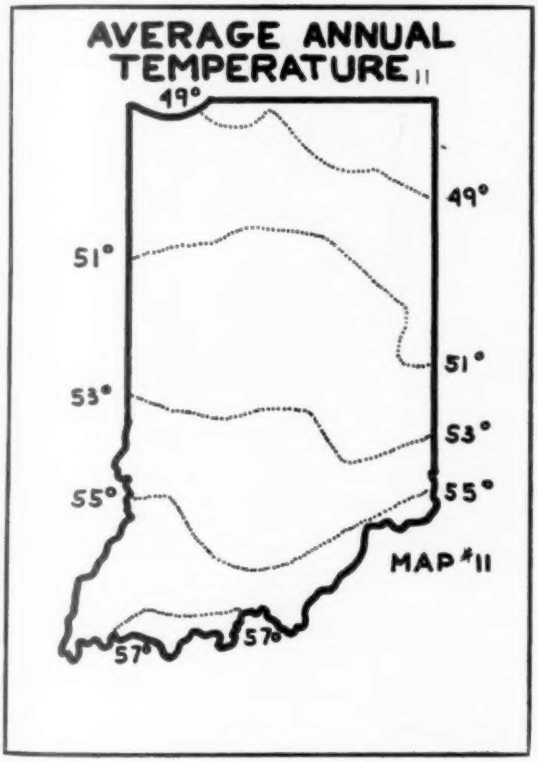

EROSION12
MAP #6
SLIGHT
MODERATE
MODERATE TO SEVERE
SEVERE


AVERAGE ANNUAL PRECIPITATION11
MAP #7
33"-35"
35"-40"
40"-44"
44"-47"
47"+

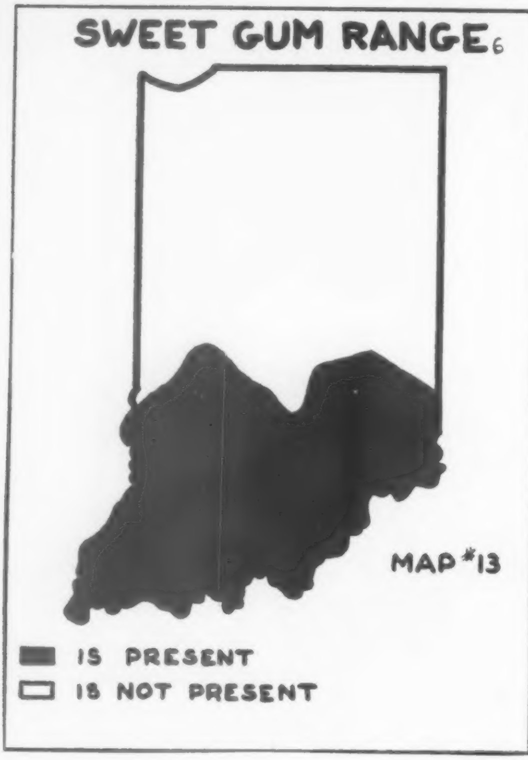

AVERAGE SUMMER PRECIPITATION11
MAP #8
11"-12"
9"-10"
10"-11"

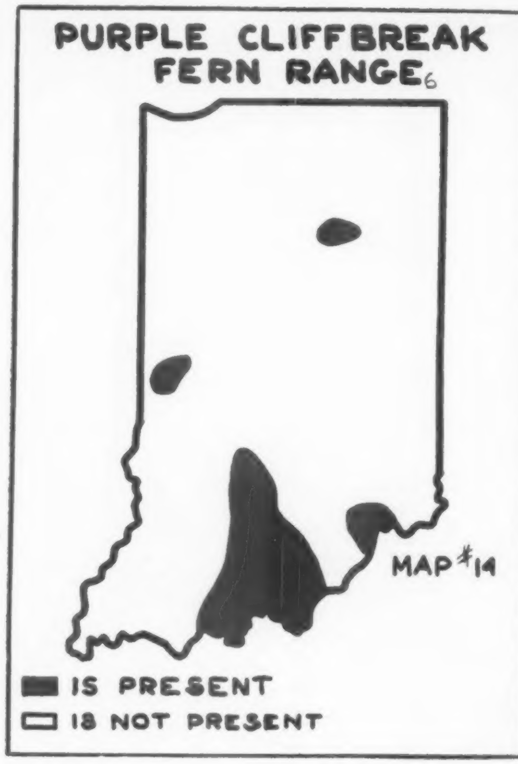

AVERAGE WINTER PRECIPITATION 12
MAP #9
8"-10"
5"-6"
10"-12"
6"-8"
12"-13"

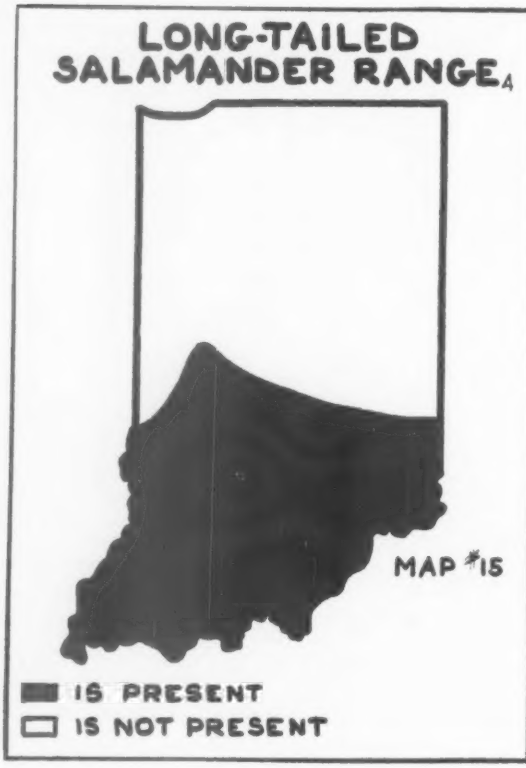

ANNUAL PERIOD FREE FROM FROST 10
MAP #10
180-200 DAYS
145-160 DAYS
160-180 DAYS

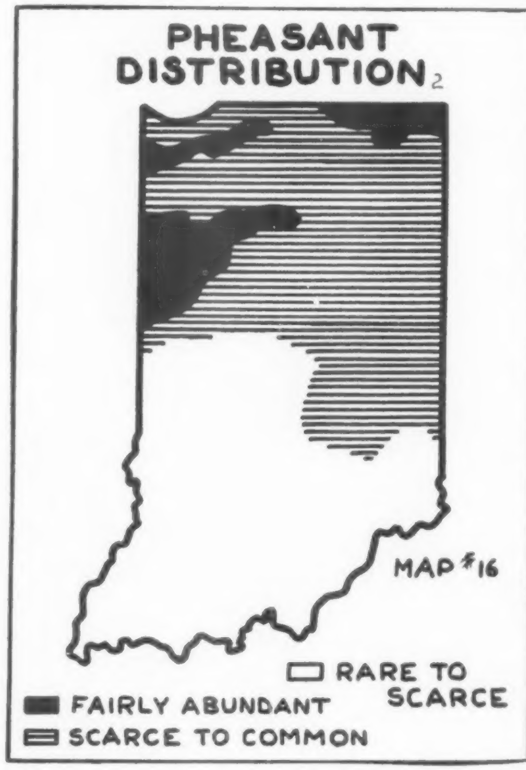

AVERAGE ANNUAL TEMPERATURE 11
49°
49°
51°
51°
53°
53°
55°
55°
MAP #11
57°
57°

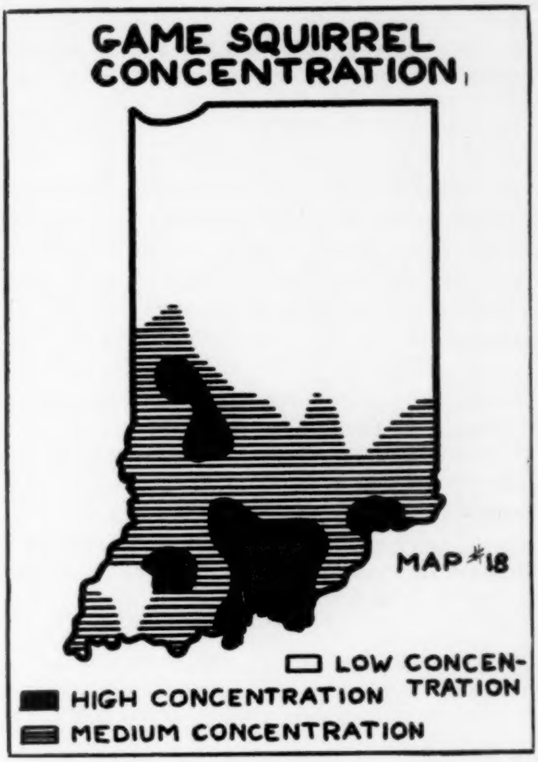

NATIVE VEGETATION 9
MAP #12
BEECH-MAPLE FOREST
OAK-HICKORY FOREST
PRAIRIE


SWEET GUM RANGE6
MAP #13
IS PRESENT
IS NOT PRESENT


PURPLE CLIFFBREAK FERN RANGE6
MAP #14
IS PRESENT
IS NOT PRESENT


LONG-TAILED SALAMANDER RANGE4
MAP #15
IS PRESENT
IS NOT PRESENT


PHEASANT DISTRIBUTION2
MAP #16
RARE TO SCARCE
FAIRLY ABUNDANT
SCARCE TO COMMON



questions may be used for testing. This is one occasion where an "open-book" test is possible, since the student will continue to use his own maps. Sometimes it may be possible to use films that are specially suited for this study. The film, *The State Beneath Us*, works well for Indiana.[3]

In preparing an exercise such as this, the choice of maps becomes quite critical. It is obvious that the maps must be as accurate as possible, since the correlations can be no better than the maps themselves. One major problem that arises after the selection of maps is the necessity to simplify many of them. A soil map listing 57 soil types will certainly be more accurate than one showing only five types, but too many categories or exceptions tend to discourage and confuse the student rather than aid him. Although the maps may be simplified to make them more easily interpreted, it does not follow that the actual conditions are simplified.

Correlations on a national level might be easier for students to see, at least, superficially. However, by approaching the study from a state level there is more initial interest—and the students really have more to gain. For the sake of success in making obvious correlations, though, it is a shame that we do not all live in states like California or Colorado where vast extremes are the rule! A state like Indiana is complex because of its relatively uniform conditions.

There are several definite advantages to be gained from this approach:

1. Students learn to evaluate data critically and to develop valid conclusions. It is one thing for students to memorize a rule about a relationship of topography to erosion. It is quite another thing for them to figure out this relationship for themselves.
2. Students learn that correlations are not necessarily complex and beyond their understanding.
3. Students come to realize that it is possible, even in as uniform a state as Indiana, to develop definite rules and patterns that control ecological relationships.
4. It is easy to integrate courses in history, economics, geography, etc., into the study.
5. It brings about a much greater appreciation and understanding of the pupils' home state.
6. It indicates some of the definite correlations possible, as well as some of the perplexing "unanswerable" questions.

[3]Available from the A-V Center, Indiana University, Bloomington, Ind.

Map Sources

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2. Allen, John M., *Indiana Pittman-Robertson Wildlife Restoration 1939-1955.* Pittman-Robertson Bul. No. 3, Indianapolis, Ind. 1955. 240 pp.
3. Belcher, D. J., et al., *The Formation, Distribution and Engineering Characteristics of Soils.* Eng. Ex. Sta., Research Series No. 87, Bull. No. 10, Purdue Univ. 1943. 389 pp.
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10. Switzer, J. E., *Georgraphy of Indiana.* Boston: Ginn and Co. 1937. 52 pp.
11. Visher, Stephen S., *Climate of Indiana.* Bloomington, Ind.: Ind. Univ. Publ. Sc. Series No. 13. 1944. 511 pp.
12. Visher, Stephen S., "Indiana Regional Contrasts in Temperature and Precipitation." *Ind. Acad. Sc.* 45:183-204. 1936.

Three new forestry publications are now available for teachers and students from the American Forest Products Industries, 1816 N Street, N.W., Washington 6, D.C. They are:

1. 22" x 34" chart on *Products of the Tree Farm.* The products are listed according to their manufacturing processes. Chemical terms are used.
2. A 1955 *Teacher's Manual* for forest conservation from grades 4 to 12.
3. 1957-1958 *Bibliography of Teaching Aids* on America's forests and industries for grades 4-12.

Attention! Collectors of insects and zoological specimens should get in touch with Mr. V. A. Van Eyck, United Scientific Company, 200 N. Jefferson Street, Chicago 6, Illinois. Mr. Van Eyck is asking for collectors to get in touch with him.

Utilizing the Frog

THOMAS G. AYLESWORTH
Michigan State University

It would seem, from personal observation, that the typical biology teacher in our high schools uses the dissection of the frog to illustrate the structure of a typical vertebrate during that unit of classification of animals which may be titled: "A Survey of the Animal Kingdom." When this unit is completed, all reference to the frog is forgotten, because the teacher must get on with other important studies: heredity, conservation, reproduction, plant anatomy, etc. Since the biology teacher generally purchases earthworms and frogs, and, if he is in exceedingly good graces with the business office of the school system, clams or crayfish, this, more often than not, constitutes the bulk of the expendable supply budget of the biology department. Let's get more use from the frog. Earthworms can be free to the energetic biologist, but frogs in quantity are something else. The purpose of this article is to give two suggestions for the utilization of the frog that might be more meaningful to the student. At current prices, the frog uses up too much of the biology budget not to be used for longer than four or five laboratory periods during the school year.

Those parts of the typical biology course which might be termed zoological are: classification, animal physiology, behavior, reproduction, heredity, and the study of cells, tissues, organs, and systems. Some of these are studied in conjunction with the plant world but still might be more easily demonstrated through the use of animal specimens. Why not use the frog throughout the studies? As we speak about digestion, students examine the vomerine teeth, tongue, glottis, esophagus, stomach, intestines, liver, pancreas, rectum, and cloaca of the frog. These, in turn, can be directly related to their homologues and analogues in man. Since virtually the only way that we can demonstrate these parts in man is through flat pictures and slides, the students have had a three-dimensional preview of the workings of the digestive system of man. When it comes time for the various chemical demonstrations or laboratory work on the

digestive process, the students can review these processes in their frog dissections.

Respiration might better be introduced by a careful observation of the respiration of a live frog. Although this process is not quite the same as would be found in man, at least it is a more graphic presentation than the common one of the two balloons inside a gallon jar. After the process has been explained, the students return to their dissections to find the nares, the olfactory sacs, the glottis, and the lungs.

Circulation of the blood is often demonstrated with an anaesthetized live frog, but we should then return to the dissection to find the main arteries and veins and perhaps do an additional dissection of the heart. Then we can continue with the discussion of these circulatory processes in man.

The excretory system of man can be previewed also. In the frog, we find kidneys, ureter, and the urinary bladder. Glandular studies can lead to the discovery of the adrenal glands, the pancreas, the testes, and the ovaries. From a study of the glands we can lead into the study of the reproductive system. Here, in addition to the sex glands, we can find the sperm ducts, oviducts, and eggs. A discussion might be started concerning the adaptations of the frog for reproduction which might well lead into the pursuit of the answers to the problem of all adaptations. Once again we return to our pictures of the various systems found in man.

Finally, the skeletal system of the frog is examined. One way to begin this study is to dissect out the bones of the frog and then to mount them on a piece of cardboard. Labels may be attached if it is so desired.

By using this technique we have studied animal physiology by using a specimen that involves the senses of sight, touch, and, unfortunately, smell in the learning process, rather than pictures, models, and preserved specimens appealing only to our eyes. The only inconvenience to the teacher is that, because of the prolonged use of the specimens, he may have to filter the formaldehyde solution from time to time. On the other hand, the student, through exploration and discovery, has learned more about physiology than that which comes from books and pictures only.

My second suggestion for effective utilization of the frog is in the semester review. The specimen can effectively reinforce the study of cells, tissues, organs, and systems. All we need is a microscope and a dissected frog. Another area for review is in the life cycle of the frog. If the school year is long enough, or the climate is warm enough, eggs can be collected, observed in cleavage, blastulation, gastrulation, and development into the hatching stage. Perhaps some of the students could stock aquaria with the tadpoles for summer observation. Here, with luck, metamorphosis could be observed at first hand. This exercise is also an effective review of reproduction.

If living frogs are available, the behavior unit may be reviewed. S-R bonds, involuntary and voluntary behaviors, and reflex actions can all be observed through the feeding of the frog, touching its eyes and nostrils, and rubbing ammonia on its jaw. Behavior and adaptations for survival become more real to the student who is fortunate enough to study a living frog.

Finally, the whole study of physiology can be reviewed through the use of the frog, as mentioned previously in this article.

In conclusion, if you are interested in getting more mileage out of your frogs, don't relegate them to the part of your course in which you study "The Typical Vertebrate." It isn't very typical. Use your frog for a whole semester, or, at least, for a week or two for the purpose of review.

Biology in the News

Brother H. Charles, F.S.C.

CHANGING PATTERN OF A NATION'S HEALTH, Life, Feb. 17, 1958, pp. 72-85.

Excellent graphic presentation of the means now being used to lengthen human life. The pictures of complex apparatus now in use gives an idea of some of the tremendous research activities now in progress. Good bulletin board material.

THRIVING ON TENSION, E. M. D. Watson, Cosmopolitan, February 1958, pp. 66-69.

Is it tension or is it the inability to relax which kills our executives? Must we use pills to keep us normal? How much tension is normal? A good article to stimulate discussion about how to live in the present day world.

WHEN DISASTER STRIKES *You* ARE THERE, Margaret Hickey, Ladies Home Journal, February 1958, pp. 25-30.

This description of the activities of the Red Cross in disaster work should stimulate students to become more active in Junior and Senior Red Cross work. It is a wonderful account of how effective volunteer activities can be when properly organized and directed.

A DOCTOR TALKS ABOUT INSOMNIA, Frank J. McGowan, F.A.C.S., McCalls, February 1958, pp. 4, 87.

Sleeplessness is common in youth only when too many exciting things claim attention. It is common in adults who have not learned to relax. Is the answer proper training or tranquilizers?

LIFE BEFORE BIRTH, Dr. Herbert Thoms and Bruce Bliven, Jr., McCalls, February 1958, pp. 35, 70-74.

Factual information about conception and the development of the child in almost month to month stages. Well done. Some copies of this deserve a place in your permanent files.

SECRETS OF MY MOTHER'S KITCHEN, Sol Fox, Sat. Ev. Post, Feb. 1, 1958, pp. 26-27, 72-73.

Some famous Jewish recipes and methods of eating them as well as of preparing them. This article could stimulate students to prepare talks and demonstrations of foods particular to their family or racial group.

HOW DOCTORS ARE MADE, Greer Williams, Sat. Ev. Post, Jan. 25, 1958, pp. 24-25, 83-86.

An account of what happens to a student who is training for medicine at Harvard. Interesting especially to those who are interested in a career in medicine. May have a stimulating effect on those who are capable of intensive work in high school but who are following the easiest path.

OUR SMARTEST GAME ANIMAL, Jack O'Connor, Outdoor Life, February 1958, pp. 33-35, 89-92.

An interesting account of the Coues deer of our Southwest written by a hunter who learns the ways of animals by living near them. This is a good example of how the work of the naturalist can effectively be combined with the joys of hunting.

Books for Biologists

MORPHOLOGY OF PLANTS, Harold C. Bold, 669 pp. $8.00, Harper and Brothers, New York, New York, 1957.

This is a relatively brief treatment of the *entire* plant kingdom for students who have had only an introductory course in botany or biology at the college level. The "type" method has been used: certain organisms have been chosen to illustrate attributes of larger groups.

THE EXPERIMENTAL CONTROL OF PLANT GROWTH, Frits W. Went, 343 pp., $8.50, Chronica Botanica Co., Waltham, Mass., 1957.

This book deals with the construction and operation of the Earhart Plant Research Laboratory, the climatic response of individual plants, and general discussion—including genotypic and phenotypic variability, analysis of growth, plant climatology, ecology, germination, photosynthesis, nutrition, water relations, methods for determining water loss, smog and periodicity, and biochemistry.

NEW CHEMISTRY, Scientific American Magazine, 206 pp., $1.45, Simon and Schuster, New York, New York, 1957.

A sampling of current activity and achievement, from basic research to industrial and consumer application, in the chemistries of high speed and high temperature, of "outlaw particles" and "free radicals," molecular "talons" and rare earths.

PLANT LIFE, Scientific American Magazine, 237 pp., $1.45, Simon and Schuster, New York, New York, 1957.

This book is about the sprouting of seeds, the pollination of flowers, the ripening of fruit, the falling of leaves as they pose fundamental questions of growth and form, genetics and evolution and the underlying chemistry of life.

HOW TO DO AN EXPERIMENT, Philip Goldstein, 192 pp., $2.60, Harcourt, Brace, and Company, New York, New York, 1957.

This book has a logical development of material, first explaining what is meant by the "scientific method." It is of a self-teaching nature, contains ideas for experiments, and other students' work. Much of the material is directed towards preparation for science fairs.

(Continued on page 90)

Dance of the Sharptails

S. M. POLICH
Stambaugh High School, Stambaugh, Michigan

On what is known as Nault's plains a few miles south of the little mining town of Alpha, Iron County, Upper Michigan, near the Chicago and Northwestern Railroad, is the staging ground and the dancing pavilion in the spring of the year for the courtship of the sharptail grouse. Those who have witnessed it for the first time or for dozens of times, continued to be awed by the strange antics of the sharptail cocks. These dancing hills or grounds can usually be located by sound, since this performance may be heard for a distance of one-half mile on a still morning. The spot chosen by the cocks is usually a slight elevation of ground with perhaps a fire-blackened pine stump or two in the nearby plains landscape. These dancing hills are repeatedly used year after year by the many succeeding generations of grouse. Game biologists check the same dancing grounds annually as an aid in the determination of the current grouse population.

The past several years the district game manager of the Michigan Department of Conservation has erected a blind at the dancing hill. It remained only for the avid naturalists to arouse themselves, slip out of the cozy comfort of warm beds and find their way to the blind by four-thirty on a frosty April morning.

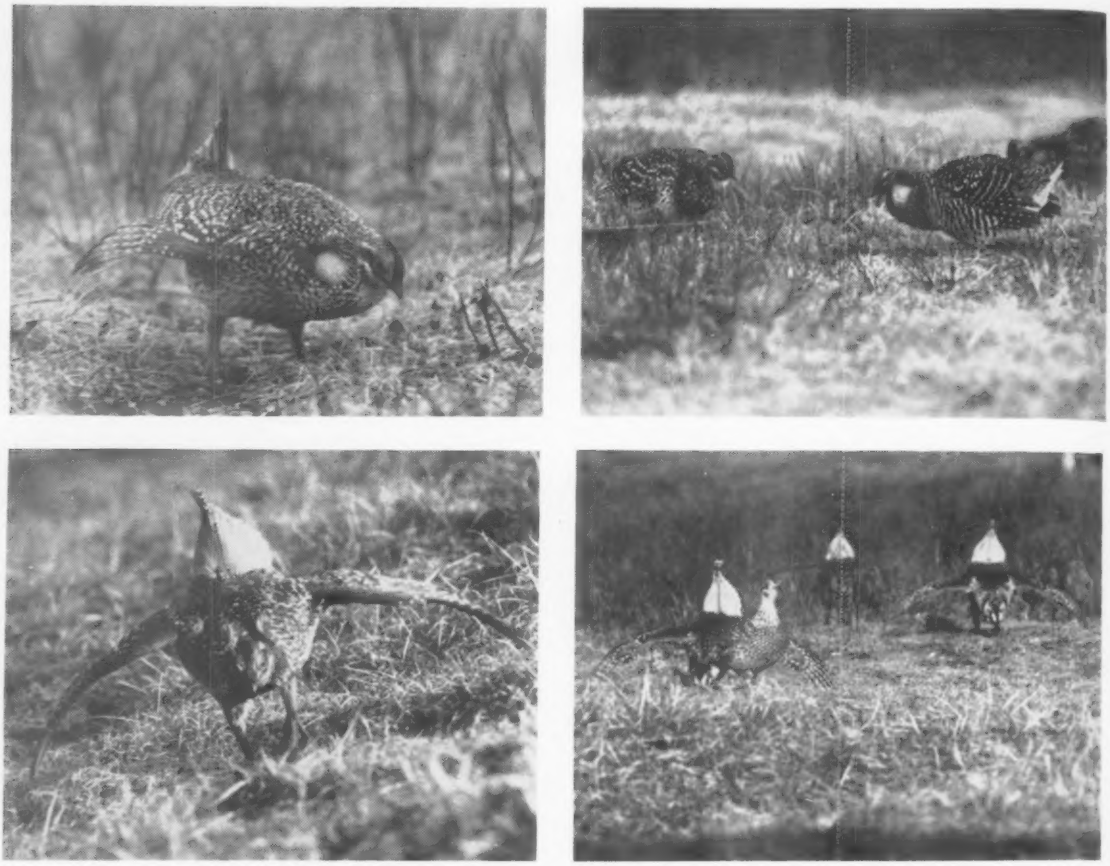
In the blind and properly instructed, teacher and pupils have not long to wait—by four-forty-five the early arrivals announce their presence by emitting strange cooings and gobbling noises, sometimes sounding like a low cackle of a barnyard hen. By some strange body chemistry, the cocks are stirred into fanciful and intricate body manipulations. This is characteristic behavior for the cocks, beginning usually in the frosty mornings of March and reaching a culmination in early May when the act of reproduction is accomplished. They may sometimes perform in the fall of the year but not with the intensity as seen in the spring mating season.

In the dark grey of the pre-dawn light, one can follow the grouse and note new arrivals by their sounds. As the night dissipates itself into dawn, the observers are able to pick out a flashy white tail which is held high in vertical position, giving display to the sharp clean white of the under feathers. This is only the part of the grouse visible as yet—the well defined upheld tail, perpendicular to the back—is like a spear stabbing the fading darkness. With so many cocks bobbing up here and there in the nearby terrain, it gives the entire area under observation a ghost-like eerie appearance.

These cocks gather here every morning to dance and fight, to coo and to gobble, establishing their right to a tiny piece of territory which invaded by another cock only with the proposition of a fight. Occasionally two cocks meet face to face and simultaneously leap into the air, batting each other with their wings while in flight, but with no harm done except perhaps the loss of a few feathers each then retreats to his own little domain.

On several occasions a lone cock is observed off to one side, suddenly leaping and taking flight straight up for about ten or twelve feet only to come down again in almost the same spot, as if the young male were putting on a display of pomp and power to attract the attention of a demure female who may or may not be present.

As the grey dawn takes on more light, the whole outline of the bird can be made out. He looks big, proud and handsome! Even the lavender air sacs now become visible. The courtship dance can now be seen in its entirety! All cocks begin their dance simultaneously as if by pre-arranged signal—by outstretching their broad wings so that the tips almost drag on the sod, the necks long and outstretched with heads held low and moving in a bobbing manner, the feathered legs prancing rapidly and almost rhythmically, cavorting pretty much in the established pathways of their self-appointed territories. There is a great commotion of sound with the cooing and cackling, and a peculiar clicking sound which is probably made by the rubbing of the outstretched feathers at this point in the dance. This continues for a variable number of seconds and suddenly all sound and motion ceases, as they began, as if by signal. At this moment all cocks "freeze," not even moving an eye, to remain so for a number of seconds;



The Dance of the Sharptails. *Illustrations courtesy Michigan Conservation Department.*

this fanciful and interesting behavior is repeated many times.

As the sun breaks over the horizon like a huge ball of fire and since we had feasted our eyes on this fascinating ritual for about an hour, we grow careless in the blind, moving more perceptibly, which immediately was reason for caution among the performers some of whom were not more than ten feet from the blind. So one by one, the nearer cocks take wing, but we were satisfied—a little chilly, cramped and hungry—we crawl out of the blind to stretch our limbs and the remainder of the flock take off toward the distant brushy hills to the northeast.

What a thrilling observation for teacher and pupils in animal behavior, for it is certain that you too will thrill at the sight of this fascinating courtship ritual of the sharptail grouse. It is available to anyone who lives in the sharptail range. You should try it!

Books for Biologists

ATOMIC ENERGY IN AGRICULTURE, William E. Dick, 150 pp., $6.00, Philosophical Library, Inc., New York, New York, 1957.

The author describes how atomic energy may not only speed up plant breeding and make possible the production of varieties of agricultural plants hitherto impossible to obtain, but how it can also be used in other fields of vital importance. Atomic energy can be used to destroy and control pests and diseases, and the possibilities of its future development provides one of the most potentially fruitful and fascinating stories of the growth of peaceful uses of atomic energy.

DICTIONARY OF DIETETICS, Rhoda Ellis, 152 pp., $6.00, Philosophical Library, New York, New York, 1956.

This book is a compilation of terms and references related to diet and diet therapy. It is of interest to both lay and professional people who are concerned about diets, nutrition and foods, as well as dietetics.

Aquatic Biology Field Trips[1]

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A friend once remarked to me, "I feel so sorry for you aquatic biologists." "You are so limited in where you can go on a field trip. You must pick out a definite spot where there is a body of water and you don't have the whole horizon for your laboratory." My somewhat joking reply to him was, "Well, at least we are not like Don Quixote after his encounter with the windmill and rode off in all directions at once to spread himself thinly over the horizon."

By virtue of the nature of our selected areas for study, we are permitted to FOCUS, rather than to scatter our attentions.

My reply was intended in no way reflect upon any other field of out-of-door study nor to imply any bit of ineffectiveness in any other area of study. I was only being quick to take advantage of a chance to point out that aquatic biology, instead of limiting us, offers a wonderful opportunity to FOCUS on nature. And—if our oculars are open, and if our objectives are focused on aquatic biology—properly focused, then this proper combination of oculars and objectives will magnify nature's secrets to the point of becoming not only very revealing, but very fascinating as well.

We who are engaged in the business of teaching biology realize that today more than ever does the world need trained scientists, and today more than ever does our job become one of salesmanship—good salesmanship, of salesmen who are thoroughly sold on the commodity in which they deal. And heading the list of these many commodities is that of *enthusiasm*, for without that one, the other responsibilities of our salesmanship transaction may soon sink into little more than drudgery. This is not only just my problem in my teaching, not just the problem of a few of you, but the problem of every biologist who turns out enthusiastic students who go from high school on to college or university and from there on to graduate school. That this problem is becoming widely realized is shown by several articles appearing in *The American Biology Teacher* Calvin Fremling's very fine article on "Biological Frontiers" and Miss Irene Hollenbeck's stimulating articles on marine as well as other phases of aquatic biology are only a few of the many fine articles you have been privileged to read in the past few years. And who knows better than a teacher of the natural sciences the joy of seeing this properly directed enthusiasm spread through a group of students like the very contagious thing it becomes: Or who, more than a teacher, is aware of the "acquired immunity" that an individual or a group may develop to this same enthusiasm of which we speak if there is misguided leadership, or, what is equally as bad, failing to capitalize where we can get in some of our "best licks."

A young boy was told once to read the Bible. He started in the front of the book, and after he had read the first four chapters of Genesis, put the book aside and reported to his teacher that it wasn't interesting—it was just like reading a telephone directory, and many of you will know the reason for his comment. But had someone taken the time to first introduce him to a book of the true life romances of Ruth or Esther he would have been fascinated. Every beginning study needs not only motivation but expert guidance.

It seems that everyone has an inborn interest in, and a desire to be around, a body of water. Whether this is a bit of evolutionary nostalgia or genuine interest has not been determined. Even as a small boy I can recall a sincere love for water—in its native state, that is!

In making inquiry of my university classes as to how many of them had made a field trip in aquatic biology only rarely do I find an affirmative answer. Many report no field trips of any kind taken in high school. A few report that their teacher took them out to the school grounds to see how many trees they knew and only occasionally a report of what would seem to be a carefully planned out-of-

[1]Paper presented at the NABT meetings, American Association for the Advancement of Science Annual Meeting, Indianapolis, December, 1957.

This view is taken on New Providence Island of the Bahamas. Although this picture was made in the Ardastra Gardens, the Traveller's Palm (not a true palm but a member of the banana family) is found throughout the West Indies. It is of particular interest to a biology class because a knife plunged into the base of any of the leaves will result in a very rapid and forceful liberation of almost a teacup of palatable water, hence the name Travellers Palm.

This picture was taken along the north shore of Sanibel Island which is located southwest of Fort Myers, Florida. We include Sanibel Island because it is world famous for its "shelling." Shell collectors from all parts of the world come here to study. One finds it impossible to walk along this beach without stepping on shells, so abundant are they. In this picture is shown a mound of shells paralleling the water's edge, which at this time of day is about 3 or 4 feet sea-ward from the mound of shells. This mound of shells is somewhat covered by wave-deposited bits of kelp. Each student is making a shell collection to be studied and classified later in the laboratory. The large lace-leaved trees in the background are Casuarinas which are so abundant and so characteristic of the West Indies and southern Florida.

door study making use of what nature has to offer us. I lament along with the poet when he says:

> "The treasure lying at your feet, whose value you but faintly guess,
> Another worker looking on would barter Heaven to possess."

I have been interested in casually chatting with students after their first aquatic biology field trip to learn what phases of the trip impressed them most. One rather common reaction is expressed in the comment of one student who said, "I was impressed by the fact that all of these things that you read and talk about are really there—there actually *are* that many living things in the world!" Or another that, "I hadn't realized that one could get such a wide variety of life in such a small area," or "I hadn't stopped to think that there were places a biologist can go on a field trip where the collecting is as good in the middle of the winter as in the summer." And when the requests begin coming in for another trip, and this time—"on Saturday, so we can stay longer," then you know you are beginning to "hit pay dirt."

And no biologist can well afford to allow his head to get so high in the clouds of minutia that the students fail to see the important things through the fog of unrelated details. General observations come first—minute details may follow. To expect students to have at their command everything that is known about the blastula of a whitefish, and yet not even recognize a whitefish when they are in the field is a "biological crime." In other words, let's keep the oculars and objectives together when we focus. And here may it be emphasized that "hitting pay dirt" on a field trip doesn't just happen by itself! Field trips that really pay-off aren't just "like Topsy." They must be carefully planned and the teacher should, in all fairness to himself as well as his students, make a practice run by himself to thoroughly familiarize himself with the place. Taking your students to a place with which you are unfamiliar is about as fair to them as to yourself if you were to go to a surgeon who would tell you just before your operation, "No, I've never seen an appendix operation, much less done one, but I've *read* all about them so have no worries, we'll get along alright." True enough, it may sometimes be a matter of good psychology and aid in the contagion of enthusiasm to *appear* to be surprised, but unless you have planned for them you may have a few surprises.

We have all seen interesting things happen to students on field trips. There is the instance of the young lady who was too squeamish to even touch a frog in the lab, but in the field she digs right in the net and barehanded pulls out fish and crayfish—and even a frog—along with the rest of them—and enjoys it! Or there is the "hermit" student who never speaks to anyone in the classroom, but on the trip you find that he *does* know fish and seems to enjoy helping everyone else in the class, and before long he is helping everyone and talking more and making more friends that day than a whole semester on the campus. That, too, is biology—human biology! These experiences can be multiplied many times in the field work of each of us.

Colleges and universities where counselling and loan service has been set up report that by far the most frequent inquiry is, "How can I create interest and enthusiasm?" There are several replies to that one. First and most obvious—*you can't give away something you don't have.* You yourself must have an enthusiasm that fairly bubbles over otherwise you are putting yourself in a class with the almost apologetic life insurance agent who hesitatingly knocks on the prospective customer's door and then says to him, "I don't suppose you'd care to buy any life insurance today would you?" And the customer isn't going to argue with him—what else can he say but—*no!* Another reply to the "interest-enthusiasm" question is, meet your students on the ground of most common interest. As an experiment some time, ask any non-biology group chosen at random whether they would prefer a trip to the prairie, forest or lake. You may be surprised at the majority by which the body of water choice will win. But here again let me hasten to add that I know from observation that students can be just as fired with enthusiasm for prairie or forest as for lake or stream, but I am convinced that the easier approach is the aquatic one.

Here may I ask your pardon for bringing in a certain case in point. At Illinois State Normal University we take pride in the fact that when we arrange our biology majors by classes, we find a greater number of sophomores than freshmen, a greater number of juniors than sophomores, and a greater number of seniors than juniors—a progression which is

View taken at Marineland, Florida, just south of St. Augustine. Here the shore is largely composed of coquina stone and forms a very fine habitat for algae—particularly the brown algae. Such shallow areas, as evidenced by the breaking wave, make for very easy and very impressive collecting.

quite the reverse of that found in many schools. I take no credit for this progressive growth, it is the result of departmental philosophy and policy which we believe to be sound.

We are among the first inland universities to offer a course in marine biology. This course carries two hours of credit. The field work is done the last two weeks in March of each year. The field work is both preceded and followed by class and laboratory as well as library investigation. Our field areas include the Florida east and west coasts, deep-water diving and collecting in the Gulf of Mexico as well as considerable work in the West Indies. Our field work as far as Miami, Florida, is carried on using a chartered bus and from Miami we fly by commercial airline to the Bahama Islands.

At this point some of you might wonder at the cost of a course which enables students from a mid-America university to study marine biology along the Gulf Stream in the Caribbean area. May I say that the cost of this is entirely borne by the students. This year the all-expense price per student including food, lodging, admissions, fees, all travel—air, land and water, will be $172.00 per student. Unfortunately we find it advisable to limit the size of this course. For convenience in travel, collecting and instruction we have set the maximum enrollment at 27 students. We always have a waiting list to enroll in this course.

The West Indian area is included in our

field work for several reasons. Nowhere in the world will the water be found to be any clearer for diving and underwater collecting—as well as photography. Furthermore, being bathed as these islands are by the edge of the Gulf Stream, the abundance and variety of sea life compares favorably with any other area of the world. Then too, we are fortunate in the accessibility of this area, being a little over an hour's flying time out of Miami.

And what does this trip do for the student? I have seen students—boys and girls both, come up from their first dive with crinoids, corals and sponges they have collected so thrilled they can scarcely wait for their turn to go down again. Enthusiasm like that just never stops. It carries over in the classroom and about the campus upon their return. And try and understand the pride and joy of some young lady upon returning to her "campus-bound" roommates saying as she proudly displays a Posterion sponge—"*I* collected this myself, and let me tell you what else I saw down there . . ."

We now have biology students at the University whose high school biology teacher has been on our marine field study, and whose anticipation and interest are already running high. Here, certainly, is a "chain-reaction" of enthusiasm. Here are students whose joy and interest in life are growing like ever-widening circles from a stone tossed into a placid pool.

Let us consider a few of the biological aspects and implications of this study. In addition to the wide variety of collecting and identifications, one is struck with the abundance of life. One can easily demonstrate many ecological relationships—including many interdependencies. The evolutionary scale of ascending complexities becomes at once apparent. Economically the student soon becomes aware of man's relationship to the sea as well as to speculate on the future part it may play in his subsistence.

And in addition to the biological aspects, let us consider the integrating value of such a course. Physics is brought in as we study light, heat, sound and wave action. We get into meteorology for a study of climate and weather factors. Chemistry is made use of in the study of many life processes and physical relationships. The geography and geology of the area must necessarily hold an interest for us and we must go to astronomy for an explànation of tidal actions. No other study cuts across more areas of learning than a study in marine biology.

And within the area of our own field of biology there are so many fascinating facets of interest that serve to FOCUS the students attention on biology. In addition to the taxonomic and ecologic aspects already mentioned, certain features of comparative anatomy—such as "homologous structures," "vestigial parts," and various "adaptations" afford an excellent means of enabling the student to discover *water*—and more particularly, the sea as the mother of life and to relate it to his own ancestral history.

As we are all aware, nothing can quite so well crystallize a concept in a student's thinking as working with, and especially collecting, this material first-hand.

Then too, the sociological aspect of this marine biology study must not be overlooked. Being exposed to different customs, new foods, different personalities and attitudes and the realization that the student himself is now a foreigner in another land, all help to sweep away a kind of provincialism which is characteristic of all of us in varying degrees and of which we are sometimes totally unaware. A most valuable way of enriching a student's life is not only to make biology live for him but to enable him to *live biology*.

Today, as Salesmen of Science we must be careful not to omit or to minimize any approach to the customer. We may not be able to each take our classes to a marine study, although if it can possibly be arranged, the results are highly rewarding, as many of you have observed already.

We can all, however, include a pond, a lake, a slough or a river in our field study. Many include aquatic studies in their field work as an ideal way to FOCUS on nature. Let me highly recommend it to all of you and to urge its frequent and year-round use.

Time is long past for us to be merely biology teachers—we must be Salesmen of Science—the present age demands it!

In our field, more than any other, we can by failing to take advantage of all of our possibilities, literally "sell biology down the river," but with our *oculars* open and our *objectives* focused on aquatic biology—we'll "sell the river to the biologist."